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A SURVEY OF MOULTING CANADA GEESE ON THE SNOWDRIFT AND THELON RIVERS NORTHWEST TERRITORIES: 1988

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ABSTRACT

An aerial survey of moulting Canada Geese was conducted along the Snowdrift and Thelon rivers on 18-19 July, 1988. The objectives of the study were: 1) to determine the distribution and abundance of moulting Canada Geese along both rivers; 2) to evaluate the importance of key habitat sites along the Thelon River, and; 3) to record ancillary observations on other wildlife along the survey route.

We observed 94 Canada Geese along the Snowdrift River and 4447 Canada Geese along the Thelon River. Concentrations of moulting birds occurred at Grassy Island, Ursus Islands and along the north shore of Beverly Lake. The relatively modest population estimate is attributed to the late survey date. Birds which had regained flight apparently left the area before the survey was conducted.

Other observations included a total of 46 Tundra Swans, 279 Greater White-fronted Geese, and 235 Lesser Snow Geese. The Tundra Swans were scattered along the Thelon River from Grassy Island to the west end of Aberdeen Lake whereas the Greater White-fronted Geese were encountered from Ursus Islands to Schultz Lake. The Lesser Snow Geese were observed in eastern Beverly Lake and western Aberdeen Lake. Approximately 10 young Lesser Snow Geese were also present in this area.

RÉSUMÉ

Nous avons effectué un inventaire aérien de Bernaches du Canada en mue sur les rivières Snowdrift et Thelon, entre le 18 et 19 juillet 1988. Nous avions pour objectifs: 1) de déterminer la distribution et l'abondance des bernaches le long des deux rivières; 2) d'évaluer l'importance des sites jugés comme exceptionnels pour les oiseaux (Key Habitat Sites) le long de la rivière Thelon; et 3) de noter toute observation d'intérêt particulier sur la faune.

Quatre-vignt-quatorze Bernaches du Canada furent observées sur la rivière Snowdrift et 4447 sur la Thelon. Des regroupements de bernaches furent observés dans les environs des îles Grassy et Ursus, et sur la rive nord du lac Beverly. Nous attribuons ce faible nombre d'oiseaux au fait que plusieurs avaient déjà complété leur mue au moment de l'inventaire.

Nous avons également observé 46 Cygnes siffleurs, 279 Oies rieuses et 235 Petites Oies des neiges. les cygnes étaient éparpillés le long de la rivière Thelon, entre l'île Grassy et l'extrémité ouest du lac Aberdeen, et les Oies rieuses, entre les îles Ursus et le lac Schultz. Les Petites Oies des neiges furent observées entre l'est du lac Beverly et l'ouest du lac Aberdeen. Il fut impossible de déterminer le nombre d'oisons présents dan la régions.

ACKNOWLEDGEMENTS

Rick Hurst, Environment and Conservation, Indian and Northern Affairs Canada, provided generous financial assistance or this project. Our appreciation is also extended to Alex Dzubin, Rick Hurst and Bert Poston who reviewed the manuscript and to Susan Popowich who prepared the figures and arranged for the printing.

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1.0 INTRODUCTION

1.1 Key Habitat Sites

In 1984, the Canadian Wildlife Service (CWS) completed a compilation of the key migratory bird terrestrial habitat sites in the Northwest Territories (McCormick et al. 1984). Any site that supports at least one percent of the Canadian population of a migratory bird species or subspecies, for any portion of the year, is considered to be a Key Habitat Site. Evaluations are based on the best available estimates of national and regional populations and the number of individuals present at each site. Sites have been ranked with regard to updating the appropriate information and will be surveyed as financial and personnel resources permit.

Indian and Northern Affairs Canada (INAC) released the Northern Mineral Policy in December 1986. A primary concern of the mining industry is access to land for exploration and development. In this context, the Policy committed the federal government to a review of the Thelon Game Sanctuary to ensure that the lands it contained are necessary to achieve the conservation objectives for which it was established.

The Thelon Game Sanctuary includes two Key Habitat Sites: Middle Thelon River and Beverly-Aberdeen lakes. Both of these sites provide habitat for moulting Canada Geese. Most of the data pre-dates 1966, and since that time, continental goose populations have expanded considerably. Thus more current information is required to adequately assess the importance of the two sites to Canada Geese and other waterbirds. Accordingly, a three-year study was initiated to examine the distribution and abundance of moulting Canada Geese along the Thelon River and Snowdrift River, which is also known to harbour moulting geese (A. Dzubin, pers. comm.).

This report presents the results from the first survey.

1.2 Objectives

The objectives of this study were:

1) to determine the distribution and abundance of moulting Canada Geese on the Snowdrift and Thelon rivers;

2) to evaluate the importance of Key Habitat Sites along the Thelon River;
3) to record ancillary information on other wildlife in the study area.

2.0 STUDY AREA

The study area includes 200 km of the Snowdrift River from its mouth (near the community of Snowdrift) to approximately 108°W, and 1025 km of the Thelon River and associated lakes from Eyeberry Lake (63° 08'N, 104° 43'W) to the community of Baker Lake (Figure 1).

2.1 Physiography

The Snowdrift and Thelon rivers are situated within the Kazan Region of the Canadian Precambrian Shield. This region consists of great areas of massive rocks that form broad sloping and undulating uplands, plateaux and lowlands (Bostock 1970). The study area includes two units of the Kazan Region: the East Arm Hills and the Thelon Plain.

The Snowdrift River rises in Whitefish Lake (62°41'N, 106°48'W) and flows southwestward for approximately 260 km before emptying into Great Slave Lake near the community of Snowdrift (62°24'N, 110°44'W). The river flows through the East Arm Hills which are formed of down-faulted and folded, differentially eroded sediments and gabbro sills. On the north side, the resistant sills dip southerly forming broad cuestas as much as 300 m above Great Slave Lake. Most intervening valleys are flooded by arms of Great Slave Lake and other lakes. On the south side the hills are narrow and lower, ending abruptly at the fault scarp bordering the Kazan Upland (Bostock 1970).

The Thelon River originates in and near Lynx Lake (62°25'N, 106°15'W) and flows in an easterly direction for over 800 km to Baker Lake. The Thelon River flows through the Thelon Plain which includes areas of nearly flat lying sandstones and volcanic rocks that are characteristically expressed on the surface by sandy flats which are sparsely covered by vegetation (Bostock 1970). South of the river, the peneplain rises from near sea level to approximately 500 m near Kasba Lake (60°18'N, 102°07'W). North of the Thelon the land rises to a watershed about 300 m above sea level, separating the Thelon and Back rivers.

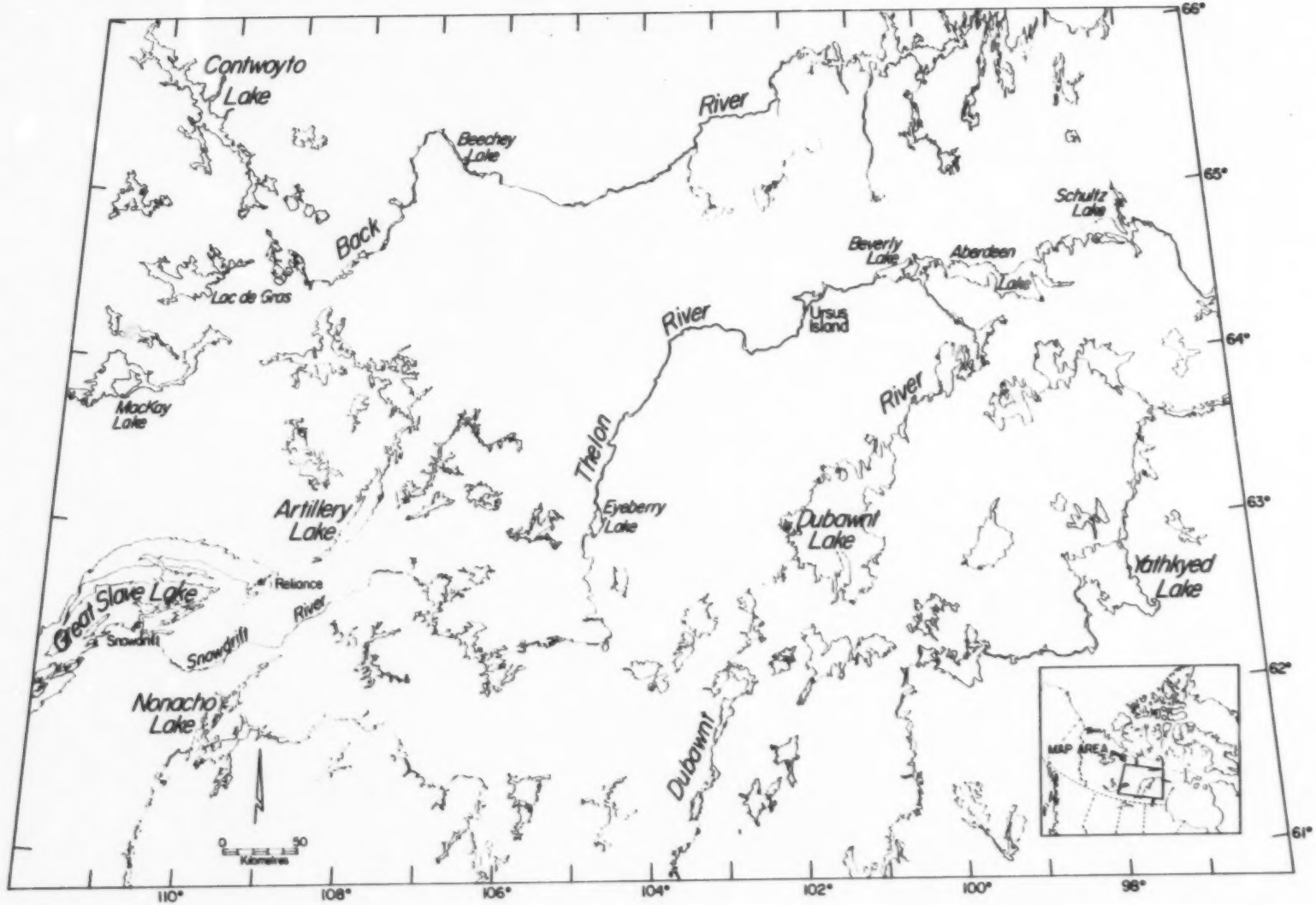


Figure 1. Map of the study area.

2.2 Surficial Geology

Although the Snowdrift River follows a narrow, deeply incised valley for much of its length, evidence of past glaciation is apparent at certain locations.Sandy areas and dunes become progressively more common east of Siltaza Lake.

The central Keewatin District was subject to multiple glaciations. Available evidence suggests that the ice originated in Hudson Bay and moved northwest across the Thelon Valley (Bird 1951). The Thelon Valley, from the Hanbury River to the east end of Aberdeen Lake was submerged at one stage by a glacial lake. Although the highest level of the lake is unknown, a raised beach is found at 225 m above sea level south of Aberdeen Lake (Bird 1951). Englacial rivers deposited deltas in the lake at the ice front and larger deltas (Grassy Island, Ursus Islands) are conspicuous features in the present landscape. Much of the once-submerged area is now characterized by deep deposits of till and sand. Sand dunes are common around Tibielik River (64°41'N, 100°04'W) and along the Thelon River between Hornby Point and Finnie River.

2.3 Climate

The Snowdrift River is subject to a subarctic continental climate (Wiken 1986). Precipitation is low (175-200 mm annually) and temperatures are cool to cold. The mean daily January temperature ranges from -17.5°C to -27.5°C whereas the mean daily July temperature ranges from 7.5°C to 17.5°C. The average annual number of frost-free days ranges from 70 to 100 (Wiken 1986).

The Thelon River is passes through an area subject to a southern arctic climate. However, the sheltered areas in the valley are likely subject to a mixture of subarctic continental and southern arctic climates. The latter is characterized by long cold winters and short cool summers enhanced by long periods of daylight. The mean daily January temperature is about -30°C whereas the mean daily July temperature is 10°C. Precipitation may range from 200-400 mm annually and the frost-free period varies from 40-80 days (Wiken 1986).

2.4 Vegetation

The Snowdrift River occurs entirely within the Taiga Shield ecozone (Wiken 1986). It is characterized by boreal forest, except in the northeast margins of the watershed where lichen woodlands merge into areas of open tundra. Stunted

coniferous and deciduous stands on the uplands contrast with the taller White Spruce (Picea glauca), Black Spruce (Picea mariana), Tamarack (Larix laricina), White Birch (Betula papyrifera), and Balsam Poplars (Populus balsamifera) in the valley. Jack Pine (Pinus banksiana) occurs on the sandy sites. Green Alder (Alnus crispa) and willows (Salix spp.) border many sections of the river. Cattails (Typha latifolia), River Horestail (Equisetum fluviatile) and other emergent species grow in the sheltered wetlands.

The Thelon River valley is characterized by an enclave of subarctic forest in an area of tundra. White and Black spruce, up to 10 m high, grow in the sheltered valley. The forested corridor stretches over 200 km between the Clarke River and Ursus Island. The forest floor is vegetated by numerous Ericaceae, bryophytes and lichens. Associated waterbodies have limited emergent vegetation, but willows and other shrubs are common along much of the river.

3.0 METHODS

The survey was flow on 18-19 July, in a Cessna 185 airplane on floats, at approximately 100 m above ground level and 160 km/h. One observer occupied the right front seat while the other was in the left rear seat. The pilot navigated along a pre-determined route which had been drawn on 1:250,000 topographic maps (Appendix 1). The route was chosen to maximize the amount of shoreline that could be observed. Where possible, both sides of the river were surveyed simultaneously along narrow stretches.

The survey route was segmented into 10 km units to facilitate the recording of data. Additional transects were flown over the Ursus Islands to complete the coverage of this area. The size and identity of all flocks of birds within sight of the survey route were noted on a cassette tape recorder and transcribed later. Observations of other wildlife were also recorded.

4.0 RESULTS AND DISCUSSION

Although the Thelon River has been known for over two centuries (Hearne 1795), modern field investigations of the system did not begin until the establishment of the Thelon Game Sanctuary in 1927. Surveys (Hoare 1930, Goodwin 1936) were undertaken to evaluate the status of Muskoxen in the region and an extensive biological survey was completed in 1936 and 1937 (Clarke 1940). Subsequent field

work by Canadian Wildlife Service personnel has expanded our understanding of the distribution and abundance of geese along the river. This work will be referenced in the following species discussions.

The accuracy and precision of aerial surveys for wildlife depend on a number of factors including the species, group size, behaviour, habitat type, weather, observer, and aircraft type. One tends to underestimate animal numbers during aerial surveys and often in an inconsistent manner. Many authors have suggested correction factors to compensate for inaccuracies (Stott and Olson 1972, Caughley 1974, Haddock and Evans 1974, Cook and Jacobsen 1979, Grier et al. 1981, Malecki et al. 1981, Caughley and Grice 1982, Savard 1982, Kavanagh and Recher 1983, Anon. 1987).

Our main purpose in this survey was to estimate numbers of moulting Canada Geese along the Thelon and Snowdrift rivers. Correction factors for moulting Canada Geese have never been published (A. Dzubin, CWS, pers. comm., R. Reynolds and G. Smith, US Fish and Wildlife Service, pers. comm.). McCormick and Arner (1986) and McCormick and Bromley (1990) suggest a correction factor of 2.0 based on studies by Haddock and Evans (1975) and Stott and Olson (1972). However, Stott and Olson's (1972) work was on wintering seaducks in the open ocean, which are far more difficult to survey than Canada Geese on a sheltered and narrow river (S.A.A., pers. obs.). Therefore, it is not reasonable to apply a correction factor for seaducks to Canada Geese. The correction factor reported by Haddock and Evans (1975) was for helicopter surveys of breeding dark geese. Scattered breeding birds are likely less detectable than groups of moulting birds, rendering the correction less applicable to our surveys. Furthermore, the imprecision of the correction factor (2.07 ± 2.81; 95% confidence limits) raises some concern about its utility. The Standard Operating Procedures manual for waterfowl surveys (Anon. 1987) recommends not correcting counts of Canada Geese, although the rationale for this is based largely on experience rather than quantitative testing (G. Smith, USFWS, pers. comm.). Some researchers conducting breeding surveys correct only counts of single birds by assuming that such birds represent pairs; group counts are uncorrected (R. Reynolds, USFWS, pers. comm.). The only other correction factor for Canada Geese that we are aware of also comes from breeding studies; Malecki et al. (1981) reported that they saw about 1.4 times as many breeding Canada Geese from a helicopter as from a Cessna 180.

The habitat type and the behaviour of the geese during our survey were very different from those on the breeding grounds. Goose observations took precedence over other observations, thereby reducing the inaccuracy associated with multiple species counts (Watson et al. 1969). The geese tended to move out into the water as the aircraft approached and so were usually very conspicuous. Therefore, we feel that we were able to see most flocks of geese that were present along the survey route.

However, underestimates increase with flock size (Cook and Jacobsen 1979). Flocks of up to 15 birds are easily counted. Flocks from about 16 to 29 birds often have to be estimated but the estimations are generally quite good (from personal simulations of counting Canada Geese using dried beans). Estimates of flocks between 30 and 200 are less accurate; however, both overestimates and underestimates are common and in large samples they may cancel each other out. For the flock sizes encountered during this survey, the estimation error is generally small (<10%), but does not clearly result in an underestimate.

Thus rather than a correction factor of 2.0, as suggested by McCormick and Arner (1986) and McCormick and Bromley (1990), we will add 10% for estimation errors and 30% for detectability errors for a correction factor of 1.4. A further point is that, for the purpose of recognizing Key Habitat Sites (see Section 5.0), we rely on winter population indices, which are essentially uncorrected counts of Canada Geese on the wintering grounds. Thus it may be more valid to compare our uncorrected counts with the winter indices. Alternatively, comparing counts of moulting birds (adults) with winter counts (adults and young) would tend to underestimate the importance sites.

4.1 Canada Geese

A total of 4541 Canada Geese was distributed throughout much of the survey route. Ninety-four birds were observed on the Snowdrift River, between Siltaza Lake and 108°20'W, whereas the remaining birds were more-or-less evenly distributed along the Thelon River, from Eyeberry Lake to Schultz Lake (97°30'W). Noticeable concentrations of birds were observed at Grassy Island (61°04'N, 116°45'W), Ursus Island (64°27'N, 101°42'W), and along the north shore of Beverly Lake (units 58-63) (Appendix 2) (Figure 2).

Moulting geese were observed in two areas along the Snowdrift River. Sixty-four birds were seen at the east end of Siltaza Lake and upstream for approximately the next 25 km. The stretch of the river is relatively lush; numerous wetlands and oxbow lakes are situated adjacent to the river. The remaining birds were observed along the stretch of river at the mouth of the Eileen River (62°32'N, 107°37'W).

Sterling and Dzubin (1967) suggested that goose populations on the Back and Thelon rivers had been increasing since the mid 1950s. Kelsall (1951) estimated that there were no fewer than 3000 birds on the Thelon River and associated lakes. They were particularly numerous from the Thelon-Hanbury junction to Beverly Lake. he also considered Grassy Island to be a major moulting and breeding area. From 1958 to 1960, Macpherson (in Sterling and Dzubin 1967) observed as many as 3000 moulting geese on the islands between Beverly and Aberdeen lakes but only scattered groups to the east of Aberdeen Lake. Chamberlain and Perroux (1961) estimated that there were more than 8000 geese in the vicinity of the Thelon-Dubawnt river junction in early August 1961.

We observed 4447 Canada Geese on the Thelon River system. Accordingly, an estimated 6225 birds were present during the survey. This total seems rather small in light of previously recorded numbers of birds and the growth of Canada Goose populations over the last two decades (A. Dzubin, CWS, pers. comm.). Approximately five percent of the geese were able to fly (labouriously) during our survey which was conducted on 18-19 July. In 1963, groups of post-moulting flying geese were observed as early as 13-16 July (Sterling and Dzubin 1967). As geese apparently leave their moulting sites as soon as flight is regained (Sterling and Dzubin 1967), many birds may have left the Thelon River before we conducted the survey.

4.2 Lesser Snow Geese

A total of 235 Lesser Snow Geese was observed. Ten birds were noted along the eastern shore of Beverly Lake and the remainder were seen in the western portion of Aberdeen Lake (Appendix 2). Clarke (1940) encountered a flock of adults and young on Beverly Lake but did not see additional birds to the east. Kelsall (1951) did not record any observations of Lesser Snow Geese. In 1963 and 1964, Sterling (A. Dzubin, CWS, pers. comm.) recorded seven nesting sites on islands

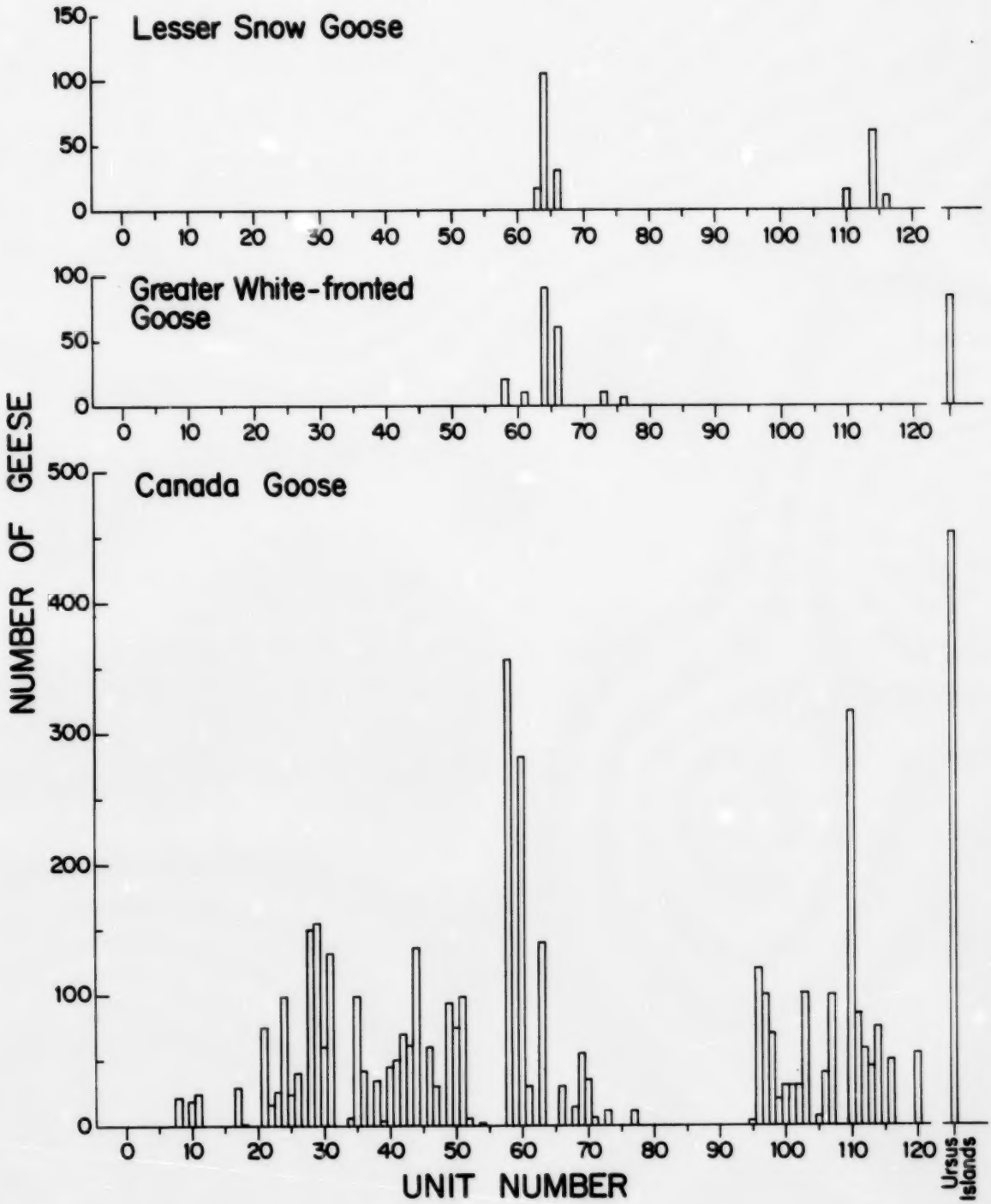


Figure 2. Distribution of geese along the survey route, 18-19 July 1988.

in the Thelon River; 5-7 km west of the the west end of Aberdeen Lake. Fifty-five nests were located at that site in 1963, and 97 nests were recorded in 1964.

Young Lesser Snow Geese were observed in transects 64 and 114. However, the exact number of young could not be determined as the birds were tightly crowded together and we did not wish to disturb them unduly. A number of islands opposite unit 64 appeared to be good nesting habitat.

4.3 Greater White-fronted Geese

A total of 279 White-fronted Geese was observed; from Ursus Island to Schultz Lake (Appendix 2). Thus, an estimated 390 birds were present during the survey. In late July 1937, Clarke (1940) observed a flock of 15 birds on the Thelon River, about 50 km above Beverly Lake. Kelsall (1951) encountered 75 birds (in three flocks) in approximately the same location. Kuyt (1962) considered the species to be an abundant breeder around Lookout Point (64°09'N, 102°32'W) in 1960. During the same year, Barry (pers. comm. in Kuyt 1962) noted at least 30 broods in a small marshy area between Beverly and Aberdeen lakes. From 1963 to 1966, Sterling (A. Dzubin, CWS, pers. comm.) located broods between Beverly and Aberdeen lake. Flocks of five to 23 moulting sub-adults without young were also present in the same area. Birds observed during our survey were in approximately the same areas that were reported previously.

4.4 Tundra Swans

Forty-six Tundra Swans were observed during the survey. The birds were distributed from Grassy Island to the western portion of Aberdeen Lake (Appendix 2).

In 1937, Clarke (1940) saw only "twelve adults spread over 100 miles and one additional bird considered to be a well-grown young one." Kelsall (1951) saw 34 swans between Grassy Island and the big bend in the river about 40 km above Beverly Lake. A number of cygnets were also present. In 1963, Kuyt (1964) encountered about 20 swans, including some cygnets, between Lookout Point and Hornby Bend.

Although different surveys covered various stretches of the river, the number of swans appears to have remained relatively constant over the years. However,

no cygnets were during our survey. There is no obvious reason for the apparent lack of breeding in 1988.

5.0 KEY HABITAT SITES

The study area includes two Key Habitat Sites - Middle Thelon River and Beverly-Aberdeen Lakes (McCormick et al. 1984).

5.1 Middle Thelon River

This site stretches from Lookout Point to the western shore of Beverly Lake (McCormick et al. 1984). In the 1960s, approximately 1500 non-breeding Canada Geese (Pacific, Hi-Line Plains, and Rocky Mountain populations) used this area during moult (McCormick et al. 1984 based on Kuyt 1966). Approximately 1330 birds were present in this area during our survey.

5.2 Beverly-Aberdeen Lakes

This site includes the shoreline of Beverly Lake and the shoreline of Aberdeen Lake to 99°10'W. This site has supported up to 10,000 moulting Canada Geese (McCormick et al. 1984). Approximately 2240 birds were present during our survey. This number, however, may not be a true reflection of the site if post-moulting birds had already left.

As noted earlier, moulting Canada Geese were distributed along much of the Thelon River. Approximately 1600 birds, representing about 26% of the Canada Geese seen, were observed from Eyeberry Lake to Lookout Point. This portion of the river may also deserve recognition as a Key Habitat Site.

LITERATURE CITED

Anonymous. 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys in North America. U.S. Fish and Wildl. Serv. and Can. Wildl. Serv. Patuxent, MD.

Bird, J.B. 1951. The physiography of the middle and lower Thelon River basin. Geol. Bull. 1:14-29.

Bostock, H.S. 1970. Physiographic subdivisions of Canada. Pages 10-30 in: R.J.W. Douglas (ed.), Geology and economic minerals of Canada. Econ. Geol. Rept. No.1, 5th ed. Geol. Surv. Canada, Ottawa.

Caughley, G. 1974. Bias in aerial survey. J. Wildl. Manage. 38:928-933.

Caughley, G. and D. Grice. 1982. A correction factor for counting Emus from the air, and its application to counts in Western Australia. Aust. Wildl. Res. 9:253-259.

Chamberlain, E.B. and J.W. Perroux. 1961. Exploratory aerial waterfowl transects, Northwest Territories, 1961. Unpubl. Rept., US Fish and Wildl. Serv., Washington. 8 pp + 2 maps.

Clarke, C.H.D. 1940. A bioligical investigation of the Thelon Game Sanctuary. Bull. No.96, Biol. Ser. No.25, Nat. Mus. Can., Ottawa. 135 pp.

Cook, R.D. and J.O. Jacobson. 1979. A design for estimating visibility bias in aerial surveys. Biometrics 35:735-742.

Goodwin, G.C. 1936. 8000 miles of wilderness. Nat. Hist. 37:421-434.

Grier, J.W., J.M. Gerrard, G.D. Hamilton, and P.A. Gray. 1981. Aerial-visibility bias and survey techniques for nesting bald eagles in Northwestern Ontario. J. Wildl. Manage. 45(1):83-92.

Haddock, J.L. and C.D. Evans. 1974. Spring bird populations on Alaska's arctic slope. Unpubl. Rept., US Fish and Wildl. Serv., Anchorage. 44 pp.

Hearne, S. 1795. A journey from Prince of Wales Fort in Hudson's Bay to the Northern Ocean, in the years 1769, 1770, 1771, and 1772. London.

Hoare, W.H.B. 1930. Conserving Canada's Musk-oxen. Appendix B. Notes on the Musk-ox and the Caribou by R.M. Anderson. Dept. Int., Ottawa.

Kavanagh, R. and H.F. Recher. 1983. Effects of observer variability on the census of birds. Corella 7(5):93-100.

Kelsall, J.P. 1951. The Thelon Game Sanctuary, 1951. Unpubl. Rept., CWS-8-51, Can. Wildl. Serv., Edmonton. 29 pp.

Kuyt, E. 1962. White-fronted Geese breeding in the Thelon Valley, NWT. Can. Field-Nat. 76:224.

Kuyt, E. 1964. Downstream movement of moulting Whistling Swans, Thelon River, NWT. Blue Jay 22:12-13.

Kuyt, E. 1966. Further observations on large Canada Geese moulting on the Thelon River, Northwest Territories. Can. Field-Nat. 80:63-69.

Malecki, R.A., F.D. Caswell, R.A. Bishop, K.M. Babcock, and M.M. Gillespie. 1981. A breeding-ground survey of EPP Canada Geese in Northern Manitoba. J. Wildl. Manage. 45(1):46-53.

McCormick, K.J., M.E. Adams, C.J. Stephenson, and A.S. Goodman. 1984. Key migratory bird terrestrial habitat sites in the Northwest Territories. Unpubl. Tech. Rept. 84-6, Can. Wildl. Serv., Yellowknife. 175 pp.

McCormick, K.J. and B.D. Arner. 1986. A survey of moulting Canada Geese in the Bathurst Inlet and Back River areas, Northwest Territories: 1984. Unpubl. Tech. Rept. No.86-1, Can. Wild. Serv., Yellowknife. 62 pp.

McCormick, K.J. and R.G. Bromley. 1990. A survey of moulting Canada Geese in the Bathurst Inlet and Back River areas, Northwest Territories: 1986. Tech. Rept. Ser. No.80, Can. Wild. Serv., Western and Northern Region.

Savard, J.-P.L. 1982. Variability of waterfowl aerial surveys: observer and air-ground comparisons - preliminary report. Prog. Notes No. 127, Can. Wildl. Serv., Ottawa. 6 pp.

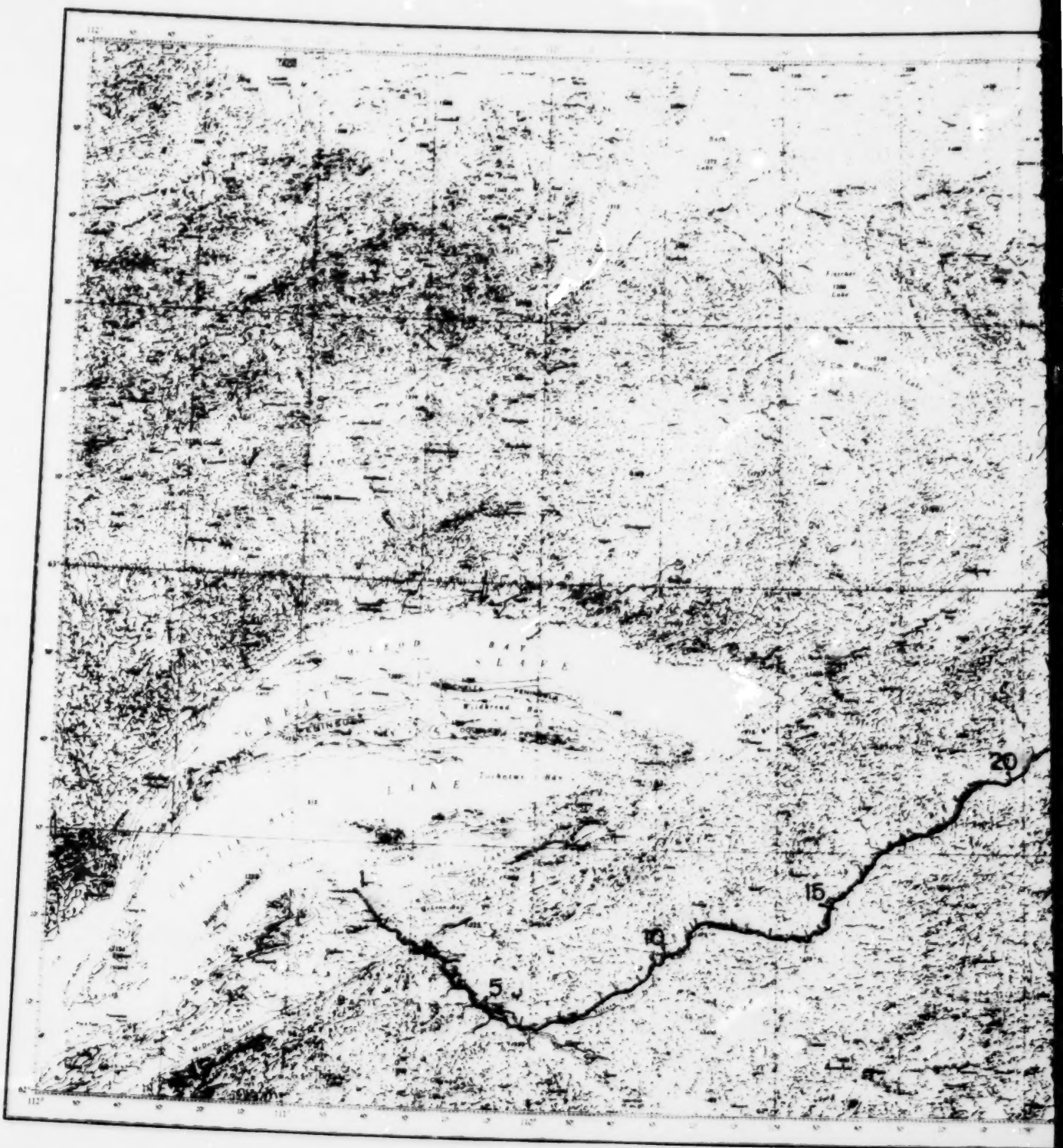
Sterling, T. and A. Dzubin. 1967. Canada Goose molt in the Northwest Territories. Trans. N.A. Wildl. and Nat. Res. Conf. 32:355-373.

Stott, R.S. and D.P. Olson. 1972. An evaluation of waterfowl surveys on the New Hampshire coastline. J. Wildl. Manage. 36:468-477.

Watson, R.M., G.H. Freeman, and G.M. Jolly. 1969. Some indoor experiments to simulate problems in aerial censusing. East Afr. Agric. For. J. Spec. Issue. 1969:56-59.

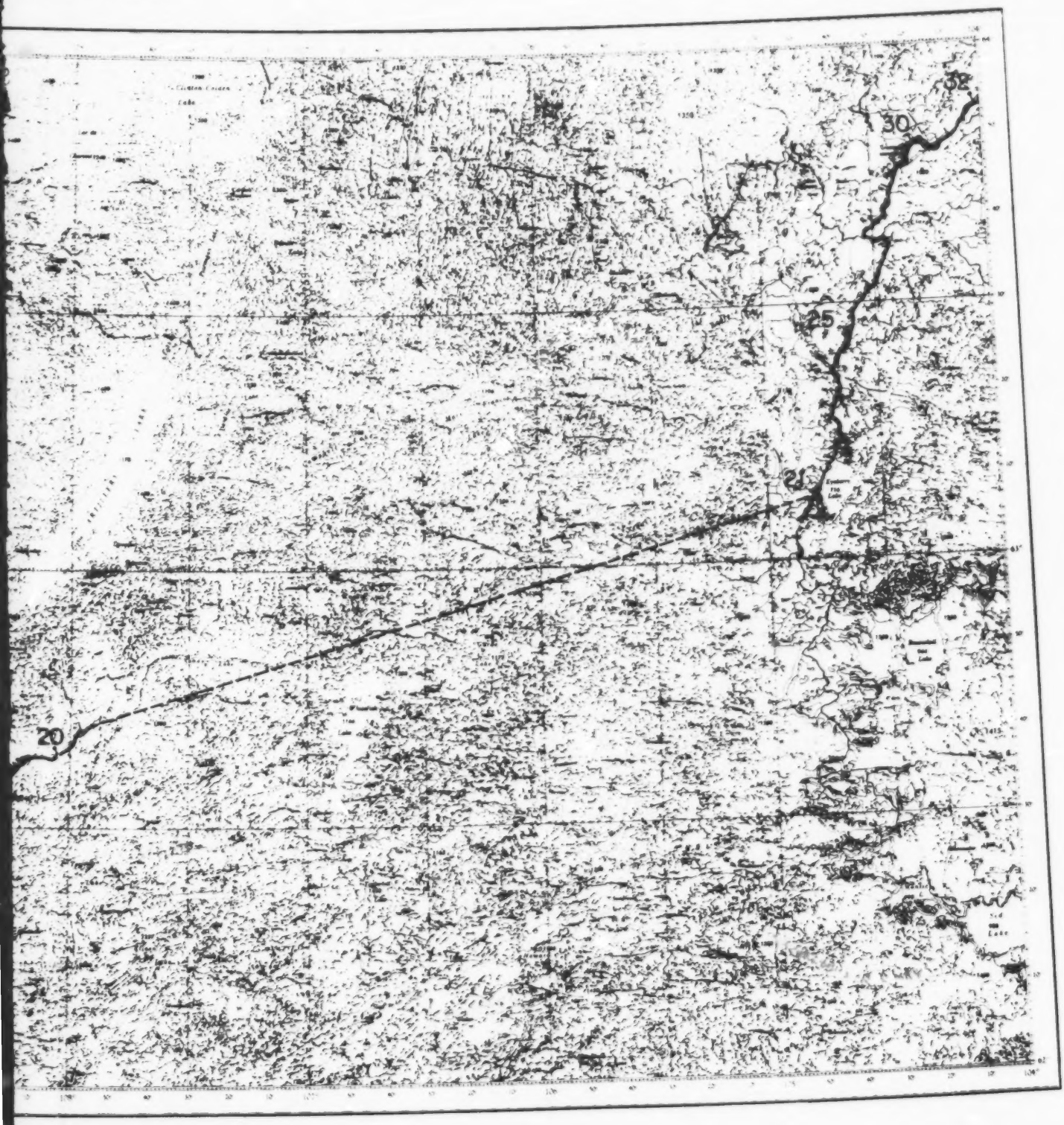
Wiken, E. 1986. Terrestrial ecozones of Canada. Ecol. Land Class. Ser. No. 19, Lands Dir., Environ. Can., Ottawa. 26 pp.

Appendix 1. Map of the route surveyed along the Snowdrift and Thelon rivers, 18-19 July 1988.


1
5
10
15
20
0

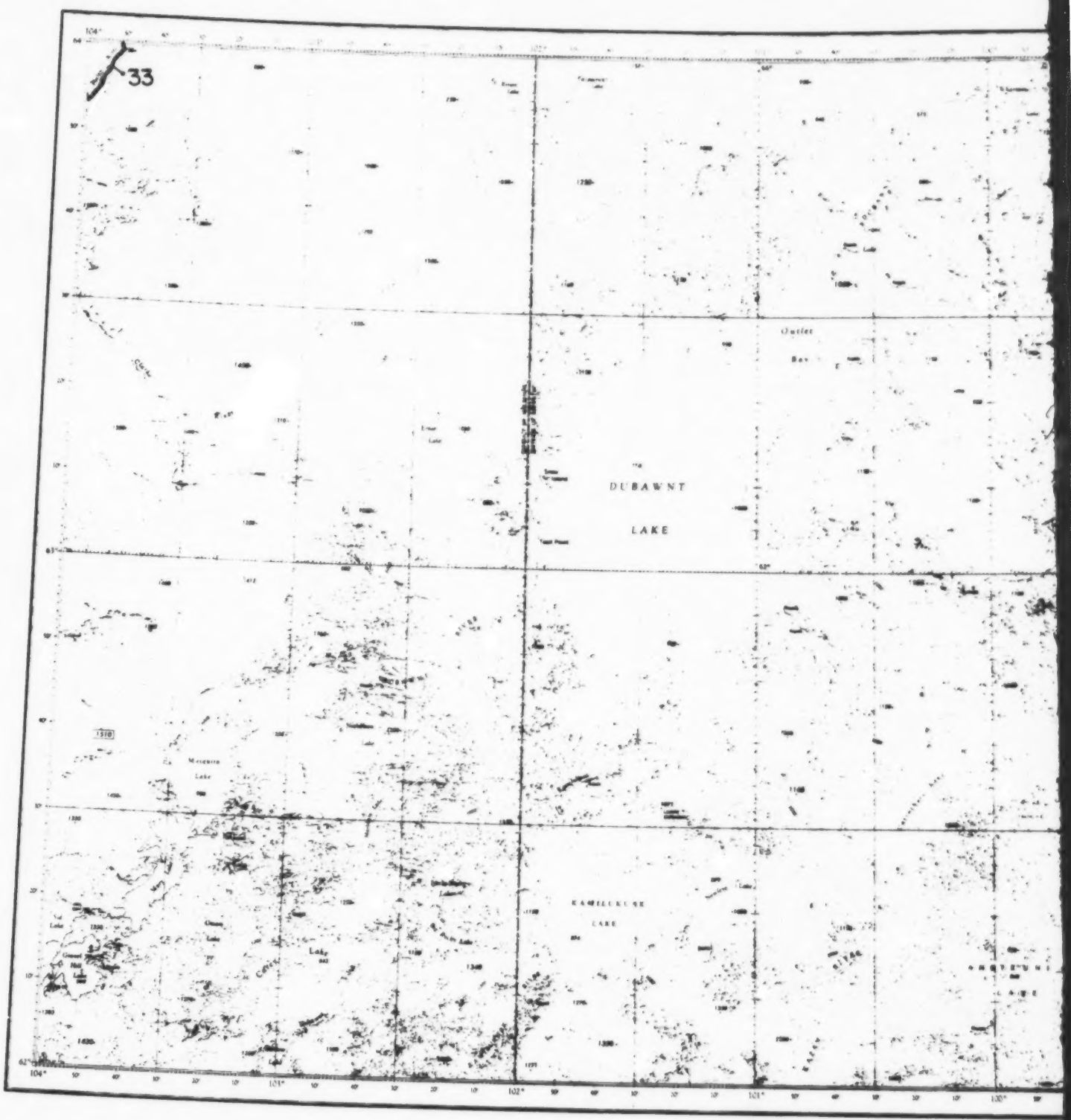
RTILLERY LAKE

75 N.W. & 75 N.E.



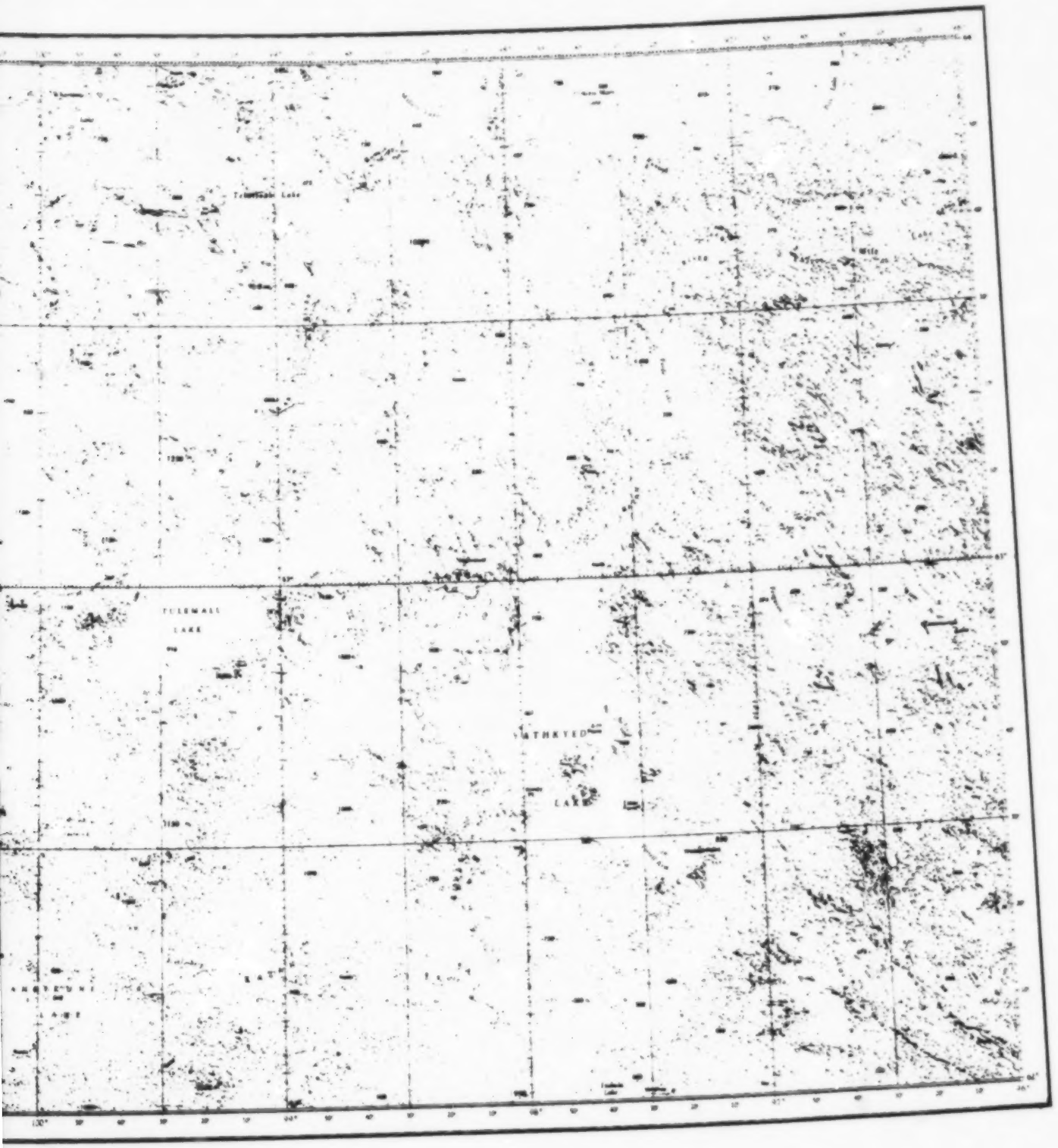
100
Kilometres

—— SURVEY ROUTE


33
DUBAWNT
LAKE
Outlet
Bay
Meadow
Lake
KAMILUKUAK
LAKE
Lake
Kilometres

AWNT LAKE

65 N.W. & 65 N.E.



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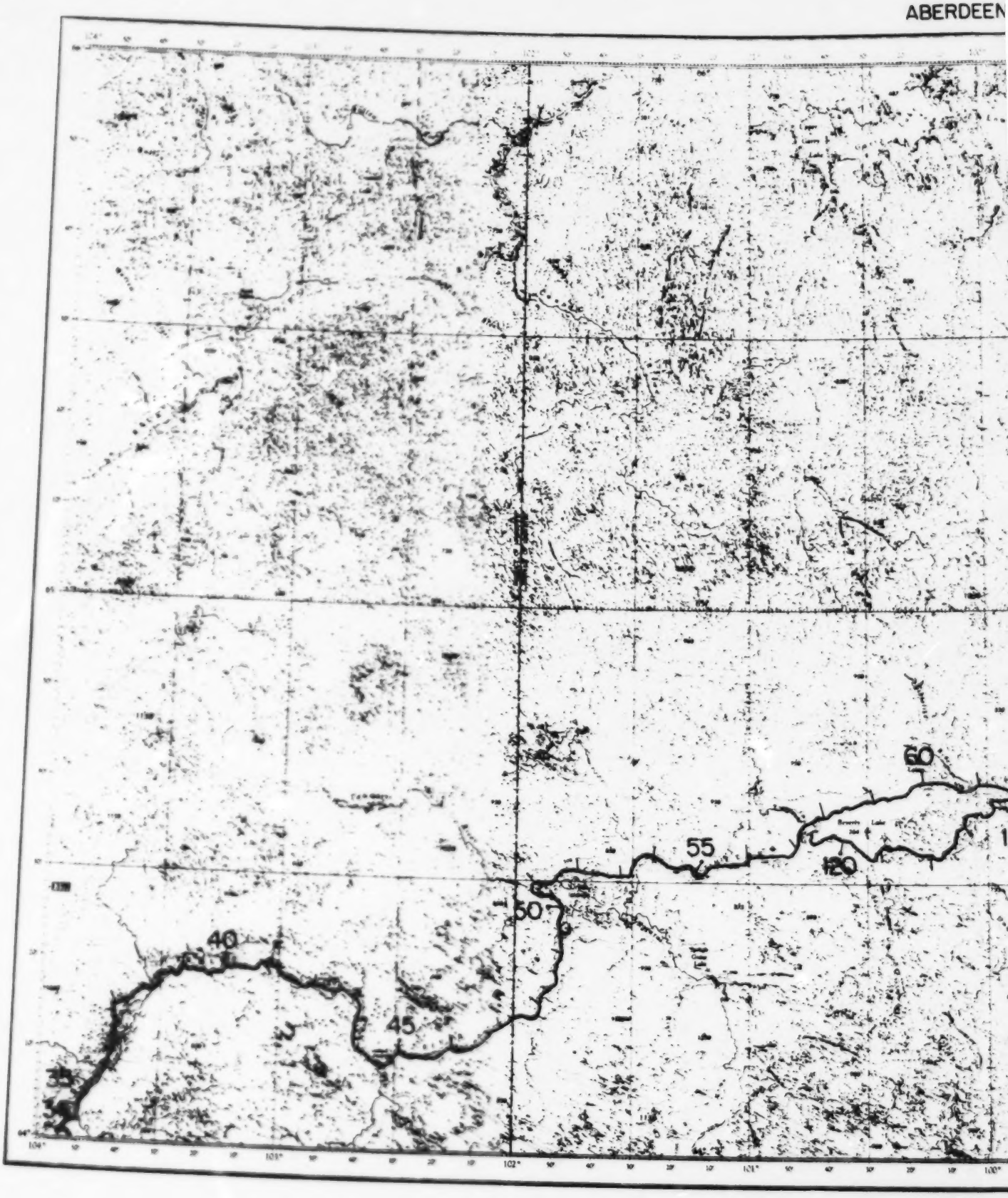
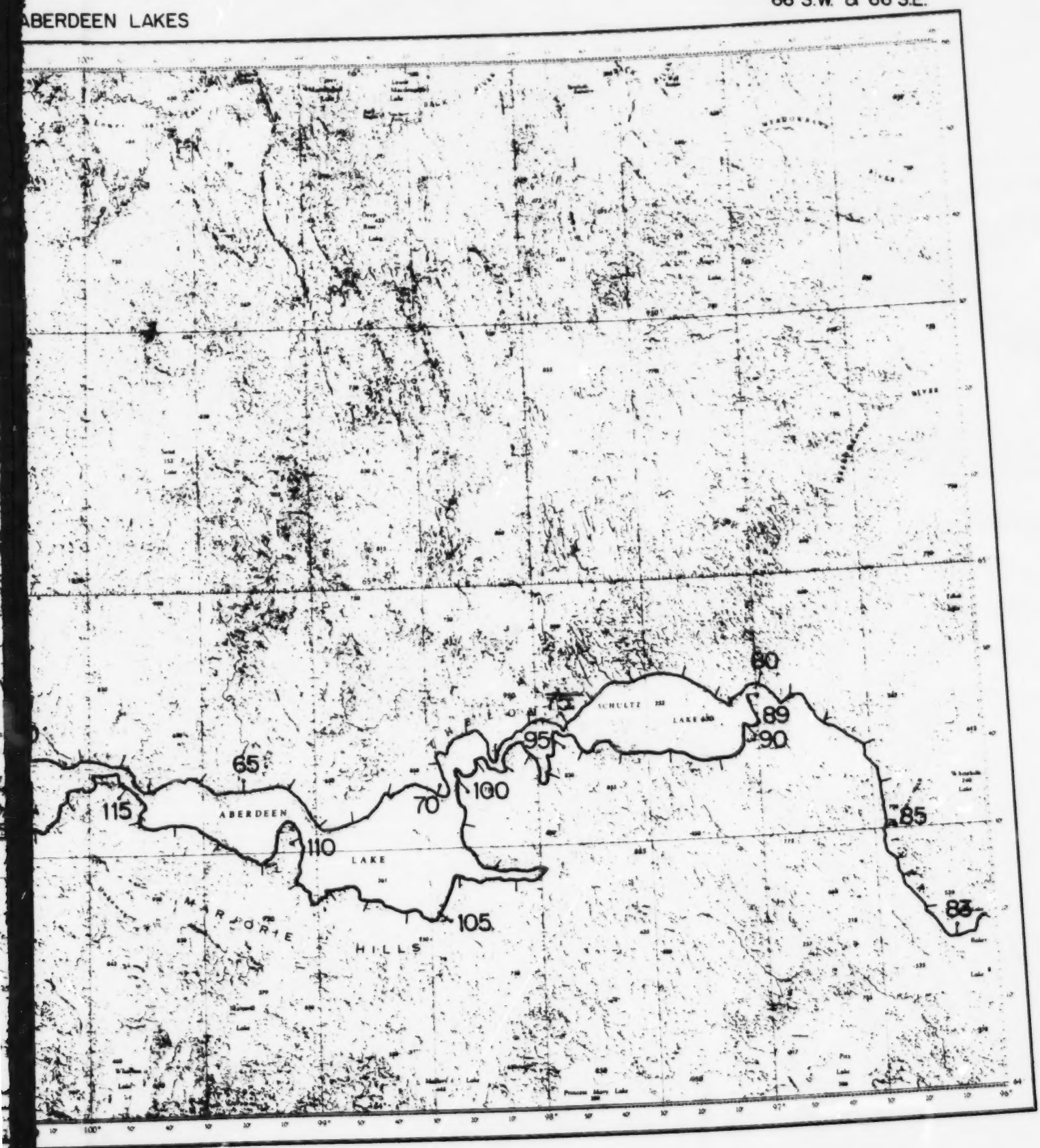
Kilometres

—— SURVEY ROUTE


60
55
50
45
40

66 S.W. & 66 S.E.

ABERDEEN LAKES



Appendix 2. Birds and mammals observed along the Snowdrift and Thelon rivers during aerial surveys conducted 18-19 July 1988.

Appendix 2a. Birds and mammals observed in 10 km segments along the Snowdrift River during an aerial survey on July 18, 1988 (segment numbers as in Appendix 1).

	Birds						Mammals			
Segment	RTLO	TUSW	GWFG	SNGO	CAGO	BAEA	GB	MO	CA	MU
7						1				
8					22					
10					18					
11					24					
13								16		
17					29					
18					1					

Appendix 2b. Birds and mammals observed in 10 km segments along the Thelon River during an aerial survey on July 18-19, 1988 (segment numbers as in Appendix 1).

	Birds						Mammals			
Segment	RTLO	TUSW	GWFG	SNGO	CAGO	BAEA	GB	MO	CA	MU
21					75					
22					16					
23					26					
24					99					
25					23					
26					40					
28					150					
29		3			155					
30					60					
31		1			132					
34					6					
35					99					
36		4			43					
37		2								
38					34					
39					3					
40					45					
41					50					
42		2			70					
43					62					
44		1			136					
46		1			60					
47					30					
49					94					
50					75					
51		6			98					6
52		4			5					
Ursus Is		6	83		453					
53		2								
54					2		1			1
57										1
58			20		357					2
60		6			282					
61			10		30					
63				16	140					
64			90	104						
66			60	30	30					
68					14					
69					55					
70					35					
71					6					
73			10		11					
75									1	
76			6							
77					12					
95					3					

Appendix 2b. Continued

Segment	Birds						Mammals			
	RTLO	TUSW	GWFG	SNGO	CAGO	BAEA	GB	MO	CA	MU
96					120					
97					100					
98					70					
99					20					
100		2								
101					30					
102					30					
103					101					
105					7					
106					40					
107					100					
110					317					
111					85					
112		1			58					
114	2	2		60	75					
115		5								
116				10	50					
120					55					

Appendix 3. Scientific names and letter-codes for species of birds and mammals observed during aerial surveys of the Snowdrift and Thelon rivers.

Common Name	Code	Scientific Name
Red-throated Loon	RTLO	*Gavia stellata*
Tundra Swan	TUSW	*Cygnus columbianus*
Greater White-fronted Goose	GWFG	*Anser albifrons*
Lesser Snow Goose	SNGO	*Anser caerulescens caerulescens*
Canada Goose	CAGO	*Branta canadensis*
Bald Eagle	BAEA	*Haliaeetus leucocephalus*
Grizzly Bear	GB	*Ursus arctos*
Moose	MO	*Alces alces*
Caribou	CA	*Rangifer tarandus*
Muskox	MU	*Ovibus moschatus*